

The Effect of Plyometrics Training and Strengths on Power Skills and Agility of Male Players in Extracurricular Volleyball

Wiga Nurlatifa Romadhoni
 Master Program in Sport Sciences
 Universitas Negeri Yogyakarta
 Yogyakarta, Indonesia
 wiganurlatifa@gmail.com

Djoko Pekik Irianto
 Faculty of Sport Sciences
 Universitas Negeri Yogyakarta
 Yogyakarta, Indonesia
 djoko.pekik@yahoo.com

Abstract—the aim of this research is to reveal: (1) the effect of plyometrics repeated tuck jump and plyometrics standing long jump with hurdle hop training on power skills and agility, (2) the effect of plyometrics repeated tuck jump and plyometric standing long jump with hurdle hop training on the ability of power skills and agility of extracurricular volleyball male players with high and low strength, and (3) interaction between plyometrics repeated tuck jump and plyometrics standing long jump with hurdle hop training and strength (high-low) on the power skills and agility. This research was experimental done with a 2 x 2 factorial design. The population was 82 participants and sample amounted 48 participants. The data collection used pretest and posttest. Instruments used were back and leg dynamometer, jump duration of fright (df), and hexagonal obstacle. The data analysis technique used was the multivariate analysis at the significance level of 5%. The results showed that: (1) there was a different effect between plyometrics repeated tuck jump and plyometrics standing long jump with hurdle hop training on the power skills capacity and agility (value $F = 6.516$ to power skills and p value = $0.002 < 0.05$ against agility); (2) there was a significant effect difference between extracurricular volleyball male players with high and low strength on power skills and agility ($F = 15.594$ for power skills and $p = 0,000 < 0.05$ against agility); (3) there was a significant interaction effect between plyometrics repeated tuck jump and plyometrics standing long jump with hurdle hop training and high and low strength on power skills capacity and agility, ($p = 0,003 < 0,05$ to power skills and proven from value $p = 0,002 < 0,05$ to agility).

Keywords—plyometrics training, strength, power skills, agility

I. INTRODUCTION

Exercise is an important need in modern life society. In sports many factors affect the performance, including the ability to master the techniques and physical endurance. One of these competitive sports is volleyball. Volleyball is a sport with high expectations for the manifestation of motion activities where players with high level of motor and functional abilities can express the proper technical and tactical characteristics over the entire duration of the match [1].

Volleyball has a complex level of motion technique, which is not easy for everyone to do because in volleyball, required coordination of motion really can be relied upon to do all the moves that exist. In volleyball every individual needs to have a high ability in order to facilitate in forming a cooperation that can provide good results and quality [2].

The actual volleyball game is characterized by the increase of the execution speed and the default of the reaction speed, which asks for more intense training into solicited effort of the segments and of the whole body, as well as the increase of the explosive force [3]. To achieve a high level of performance, some elements from the player is required not; only perfection of technical and tactical skills, but also the expression of a high level of motor abilities, explosive power, speed and agility.

On this basis, to improve the ability of the physical condition of explosive strength or power skills and agility, a person must practice through the process of practice programmed and arranged systematically and done repeatedly so that the days of training load is increasing and it is in accordance with principle of practice.

The components of power, biomotor, agility, and strength are a much-needed prerequisite for volleyball. Power is one component of the physical condition that also determines the achievement of optimal achievement. A person who has power, is a person who has a high degree of muscle strength, high degree of speed, and a high degree of skill in combining speed and strength

Power is a functional movement depending on both the proper function of all active muscles and the speed at which these muscular forces are used. Power involves the strength and speed of muscle contraction dynamic and explosive power involves the expenditure of maximum muscle strength in the shortest possible time [4]. Almost all sports require power including in volleyball, especially power skills in activity.

As athletes age, the components of the biomotor power, agility, and strength must be progressively trained and continued because the elements of this biomotor component will decrease. In addition, an athlete who has power skills and agility is good and will easily perform movements that are explosive in a fast time. In sports like volleyball, power skills are needed by athletes to jump, both in the attack (smash) and survive (blocking).

Agility is commonly used in two contexts, changing movement velocity and performing locomotion modes other than linear sprinting. Velocity is a vector quantity characterized by speed and direction, so in a broad sense

there is an agility component to any task involving changes in either parameter [5].

Agility is highly dependent on coordination and movement control, but apart from coordination there are a substantial number of factors that affect the level of agility such as mobility of joints, dynamic balance, power and flexibility level of energy resources, strength, speed and optimal biomechanical structure of movement. Furthermore agility is the ability to maintain or control body position while quickly changing direction during a series of movements. Agility training is thought to be a re-enforcement of motor programming through neuromuscular conditioning and neural adaptation of muscle spindles, golgi-tendon organs, and joint proprioceptors.

Strength can be noted as an athlete's most important physical attribute and plays an important role in almost every sport [6]. Physiologically, strength can be interpreted as a neuromuscular ability to overcome external load resistance and internal load. In general the basic concept of improving the biomotor of power can be pursued in three ways, the first; mass or the accelerated fixed charge, two; mass remains but the acceleration is increased, and three; both mass and acceleration are equally enhanced. The strength level of an athlete is influenced by the shortness of the muscle, the size of the muscle, the proximity of the load point to the fulcrum, the level of fatigue, the type of red muscle, or white, the muscle potential, the utilization of muscle potential, technique, and muscle contraction ability. [7].

Plyometrics training is a specific training program to improve the relationship between maximum strength and explosive power, which are important components of most athletic performances. Plyometric exercise has been used in all areas of the sport to increase muscle strength and explosive power. Plyometrics refers to a training modality, mainly some form jumping or rebounding, where an eccentric "stretching" of the muscle is rapidly terminated by a powerful isometric contraction, thus initiating a myotatic stretch reflex, which enhances the subsequent concentric action [8].

Plyometrics exercise involves eccentric and then rapid concentric muscle contractions separated by an amortization period in which the transition from the 2 contractions occurs [9]. The quick transition involves the muscle's stretch-recoil or stretch shortening cycle and the myotatic reflex defined as the electromechanical delay between eccentric and concentric contraction. Activities that requires plyometric exercises includes: repetitive applied jumps (in place and standing), jumps (short and long term), hopping (short and long term) and depth jumps. Plyometric training on different surfaces may be associated with different training-induced effects on some neuromuscular factors related to the efficiency of the stretch-shortening cycle [10].

Plyometrics training in the implementation of the future, is expected to improve the ability of players who follow extracurricular volleyball, because plyometrics training is a method of training that serves to improve power skills and agility in accordance with the volleyball sports. There are

various methods of plyometrics training that can be applied to train power skills and agility to improve the ability of the jump (vertical jump), but in this study will only focus on using the type of plyometrics repeated tuck jump training and plyometrics standing long jump with hurdle hop.

The reason for the use of both types of plyometrics training above is because there are differences in the implementation of the training, where to practice plyometrics repeated tuck jump implementation does not use any tool (no obstacles) and the jump is done vertically. As for the type of plyometrics standing long jump with hurdle hop training, the implementation is done using hurdles as a hurdle jump and leap is done horizontally. Therefore, using 2 types of plyometrics training is expected to later improve the ability of power skills and agility of extracurricular volleyball male players.

II. METHOD

This research was experimental research with a 2 x 2 factorial design. The experimental study aims to compare two different treatments on the subject of the study. The factorial design is a modification of the pretest-posttest control group and the researchers add another variable. The additional variable in this study was strength.

In this study, the independent variable manipulative is plyometrics repeated tuck jump training and plyometrics standing long jump with hurdle hop training which is trained for 16 times. Frequency of exercise is 3 times in a week and the dependent variable in this research is power skills and agility extracurricular \ volleyball male players.

TABLE I. DESIGN OF EXPERIMENTAL FACTORIAL RESEARCH 2 X 2

Strength (B)	Plyometrics training (A)	
	<i>Plyometrics (Repeated tuck jump) (A1)</i>	<i>Plyometrics (Standing long jump with hurdle hop) (A2)</i>
High (B1)	(A1B1)	(A2B1)
Low (B2)	(A1B2)	(A2B2)

Description:

(A1B1): A group of players trained using plyometrics repeated tuck jump and possess high strength.

(A2B1): A group of players trained using plyometrics standing long jump with hurdle hop and possess high strength.

(A1B2): A group of players who are trained using plyometrics repeated tuck jump and have low strength.

(A2B2): A group of players trained using plyometrics standing long jump with hurdle hop and has low strength.

The population was 82 participants of extracurricular volleyball at SMA N 1 Pundong, SMA N 1 Jetis, and SMA N 3 Bantul. The sample amounted to 48 participants of extracurricular volleyball at SMA N 1 Pundong, SMA N 1 Jetis, and SMA N 3 Bantul based on calculation of sample size with Slovin formula, while sampling technique used was the simple random sampling technique. The data collection

used pretest and posttest. Instruments used were back and leg dynamometer, jump duration of fright (df), and hexagonal obstacle. Experimental group was divided into four groups of cells.

TABLE II. DISTRIBUTION OF FOUR SAMPLE GROUPS

Strength (B)	Plyometrics Training (A)	
	Plyometrics (Repeated tuck jump) (A1)	Plyometrics (Standing long jump with hurdle hop) (A2)
High (B1)	12	12
Low (B2)	12	12

III. RESULT AND DISCUSSION

Data in the results of this study were in the form of pretest and posttest data which is a general description of each of the variables involved. Pretest and posttest data of power skills and agility on extracurricular volleyball male players can be seen in table below.

TABLE III. DESCRIPTIVE STATISTICS PRETEST AND POSTTEST POWER SKILLS

Method	Strength	Statistics	Pretest	Posttest
Plyometrics Repeated Tuck Jump Training	High (A1B1)	Sum	17936.4	18381.8
		Mean	1494.7	1531.81
		SD	249.34	239.22
	Low (A1B2)	Sum	14086.8	14499.5
		Mean	1173.9	1208.29
		SD	200.169	173.54
Plyometrics Standing Long Jump with Hurdle Hop Training	High (A2B1)	Sum	16845.5	17246.9
		Mean	1403.79	1437.24
		SD	250.31	228.5
	Low (A2B2)	Sum	15440.2	15524.3
		Mean	1286.68	1293.69
		SD	198.27	168.3

TABLE IV. DESCRIPTIVE STATISTICS PRETEST AND POSTTEST AGILITY

Method	Strength	Statistics	Pretest	Posttest
Plyometrics Repeated Tuck Jump Training	High (A1B1)	Sum	151.43	146.8
		Mean	12.619	12.23
		SD	1.4007	1.013
	Low (A1B2)	Sum	162.15	147.84
		Mean	13.51	12.32
		SD	0.939	0.865
Plyometrics Standing Long Jump with Hurdle Hop Training	High (A2B1)	Sum	161.51	153.46
		Mean	13.459	12.788
		SD	0.761	0.718
	Low (A2B2)	Sum	15440.2	15524.3
		Mean	1286.68	1293.69
		SD	198.27	168.3

To further explain, the results of hypothesis testing are described as follows.

TABLE V. NORMALITY TEST FOR POWER SKILLS

Data	P	Significance	Explanation
Pretest A1B1	0.952	0.05	Normal
Posttest A1B1	0.986		Normal
Pretest A2B1	0.844		Normal
Posttest A2B1	0.941		Normal
Pretest A1B2	0.774		Normal
Posttest A1B2	0.801		Normal
Pretest A2B2	0.950		Normal
Posttest A2B2	.973		Normal

Based on statistical analysis of normality test of power skills which have been done by using Z Kolmogorov Smirnov test, all data of pretest and posttest power of limb muscle obtained result of normality test of data with value of $p > 0,05$ significance, meaning data normal distribution.

TABLE VI. NORMALITY TEST FOR AGILITY

Data	P	Significance	Explanation
Pretest A1B1	0.995	0.05	Normal
Posttest A1B1	0.951		Normal
Pretest A2B1	0.641		Normal
Posttest A2B1	0.999		Normal
Pretest A1B2	0.901		Normal
Posttest A1B2	0.942		Normal
Pretest A2B2	0.998		Normal
Posttest A2B2	0.941		Normal

Based on statistical analysis of normality test of agility which have been done by using Z Kolmogorov Smirnov test, all data of pretest and posttest power of limb muscle obtained result of normality test of data with value of $p > 0,05$ significance, meaning data normal distribution.

TABLE VII. HOMOGENEITY TEST FOR POWER SKILLS

	Levene Statistic	df1	df2	Sig.	Explanation
Pretest	0.285	3	44	0.836	Homogen
Posttest	0.596	3	44	0.621	Homogen

Based on Levene Test used for statistical analysis of homogeneity test, result of homogeneity of power skills pretest obtained a significance value equal to $0.836 > 0.05$, whereas group of posttest obtained value equal to $0.621 > 0.05$. This means that the power skills data group has a homogeneous variant.

TABLE VIII. HOMOGENEITY TEST FOR AGILITY

	Levene Statistic	df1	df2	Sig.	Explanation
Pretest	1.479	3	44	0.233	Homogen
Posttest	0.474	3	44	0.702	Homogen

Based on Levene Test used for statistical analysis of homogeneity test, homogeneity test result of pretest agility obtained a value of significance equal to $0.233 > 0.05$, while

group of posttest obtained value equal to $0.702 > 0.05$. That means the agility data group also has a homogeneous variant.

TABLE IX. RESULT OF MULTIVARIANT TEST ON POWER SKILLS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Practice method	252.542	1	252.542	6.516	0.003
Strength	654477.167	1	654477.167	15.594	0.000
Practice method* Strength	97173.002	1	97173.002	23.157	0.003

From the result, significance value α equal to $0.003 < 0.05$, meaning H_0 is rejected. Thus there is the effect of repeated tuck jump plyometrics and plyometrics training standing long jump with hurdle hop on the ability of power skills of extracurricular volleyball male players. This means that the research hypothesis that states that there is effect of plyometrics exercise on the power skills of extracurricular volleyball male players has been proven.

TABLE X. RESULT OF MULTIVARIANT TEST ON AGILITY

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Practice method	122.906	1	122.906	5.888	0.002
Strength	7527.275	1	7527.275	7.487	0.000
Practice method* Strength	107.048	1	107.048	6.064	0.002

From the result, significance value α equal to $0.002 < 0.05$, meaning H_0 rejected. Thus there is the effect of repeated tuck jump plyometric training and plyometric standing long jump with hurdle hop training against the extracurricular volleyball male players agility. This means that the research hypothesis has been proven.

IV. CONCLUSION

Based on the results of research and data analysis that have been done, conclusion can be obtained as follows:

1. There is a significant difference or influence between plyometrics repeated tuck jump and plyometric standing long jump with hurdle hop training on power skills and agility of extracurricular volleyball male players.

2. There is a significant effect in difference between extracurricular volleyball male players who have high and low strengths on power skills and agility of extracurricular volleyball male players.
3. There is a significant interaction between plyometrics repeated tuck jump training and plyometric standing long jump with hurdle hop training and high and low strengths on power skills and agility of extracurricular volleyball male players.

ACKNOWLEDGMENT

The authors would like to acknowledge the funding support from Yogyakarta State University.

REFERENCES

- [1] X. Borràs, X. Balius, F. Drobnic, & P. Galilea, "Vertical Jump Assessment on Volleyball: A Follow-Up of Three Seasons of a High-Level Volleyball Team," *Journal of Strength and Conditioning Research*, 2011, 25(6), 1686–1694.
- [2] N. Ahmadi, *Panduan olahraga bolavoli*. Solo: Era Pustaka Utama. 2007.
- [3] D. Bojanić, D. Bjelica, & G. Georgijev, "Influence of a basic motor potential on the realization of specific motor skills of elite female volleyball players," *Journal of Physical Education and Sport*, 2016, 16(2), 500–504.
- [4] A. Fenanlampir, & M. M. Faruq *Tes & pengukuran dalam olahraga*. Yogyakarta: CV Andi Offset. 2015.
- [5] T. R. Baechle, & R. W. Earle, *Essentials of strength training and conditioning*. 3rd edition. Champaign, IL: National Strength and Conditioning Association. 2008.
- [6] D. Rezaeimanesh, & P. A. Farsani, "The effect of a 6 week isotonic training period on lower body muscle EMG changes in volleyball players," *Procedia - Social and Behavioral Sciences*, 2011, 30, 2129–2133.
- [7] Sukadiyanto. *Pengantar teori dan metodologi melatih fisik*. Yogyakarta: FIK UNY. 2010.
- [8] R. S. Lloyd, R. W. Meyers, & J. L. Oliver, "The Natural Development and Trainability of Plyometric Ability During Childhood," *Journal Strength and Conditioning*, 2011, 23–32.
- [9] J. D. Stemm, & B. H. Jacobson, "Comparison of Land-and Aquatic-Based Plyometric Training on Vertical Jump Performance," *Journal of Strength and Conditioning Research*, 2007, 21(2), 568–571.
- [10] F. M. Impellizzeri, E. Rampinini, C. Castagna, F. Martino, S. Fiorini, & U. Wisloff, "Effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players," *British journal of sports medicine*, 2008, 42(1), 42–46.